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EFFECT OF WEAVING SHOP NOISE ON THE AUDITORY SYSTEM OF GUINEA P--ETC(U)
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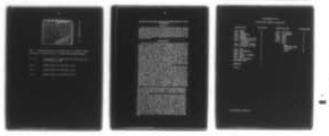

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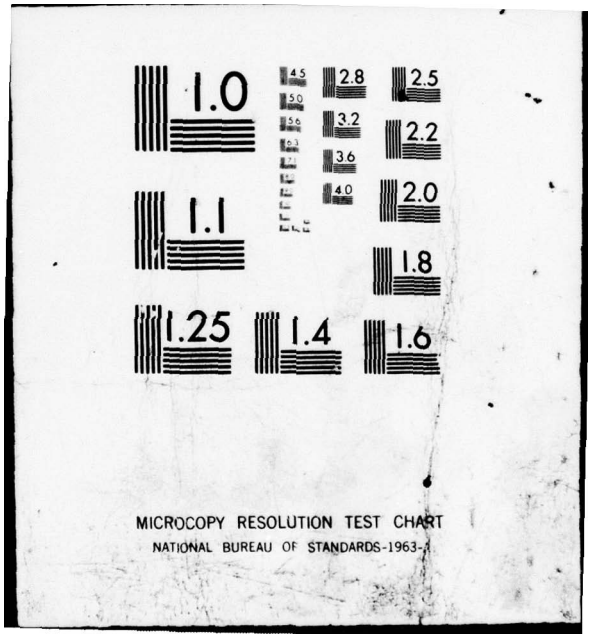
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By

T. Daniel

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FTD-ID(RS)T-0367-78 25 May 1978

MICROFICHE NR: FTD-78-C-000715

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English pages: 10

Source: Otolaryngologia Polska Dwumiesiecznik, Vol. 30, No. 4, 1976, pp. 337-345

Country of origin: Poland
Translated by: SCITRAN
F33657-76-D-0390
Requester: FTD/TQIS
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EFFECT OF WEAVING SHOP NOISE ON THE AUDITORY SYSTEM OF GUINEA PIG FETUSES*

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Threshold audiometic curves, for young guinea pigs exposed throughout their fetal life to a noise in a weaving shop were plotted using Preyer's pinna reflex. The hearing tests were performed repeatedly on the 3rd, 7th, 14th, 30th, and 60th day of life. The observations were carried out on 100 young guinea pigs.

According to Bernard et al (4), Dwornicka et al (10,11), and others, a fetus is capable of receiving external acoustical signals. This was confirmed by the measurement of microphonic potentials by Hladky, Kanigowski, Matniejewski, and Chodynicki (7) on the guinea pig fetuses. The question arose about possible hearing impairment of a fetus caused by the industrial noise. The answer to this is of great importance, since it would allow to establish correlation between the hearing impairment of the children and the industrial noise to which their mothers were exposed during pregnancy. This problem was considered by Laciak et al (22). It is worthwhile noting that according to Sobieszczanska - Radoszewska (25), 40-50% of all children with some hearing impairment do not have a known cause of this disorder. The early hearing test on newborn infants and toddlers, using available routine procedures, is very difficult to conduct on the large scale, such as to be a valid scientific survey. ~~In the early life,~~ But in the period when more accurate screening of the hearing is possible (several years after the birth), many other factors can contribute to the disorder. To establish the effect of the fetal acoustic environment on the hearing, the studies on the animals shortly after their birth were initiated.

OUR STUDIES

MATERIAL AND METHODS

The straight-haired guinea pigs were chosen for the study. This choice was dictated by the similarity in the anatomy of the inner ear of the guinea pig and

*EFFECT OF A WEAVING SHOP NOISE ON THE AUDITORY SUSTEM OF GUINEA PIG FETUSES

*Presented at a meeting of the Lody Branch of the Otolaryngological Society 7/12/74.

human (14) and also by the similar hearing range. Moreover, the Preyer's pinna reflex, which is an external manifestation of the animals reaction to the sudden acoustical stimulus, is especially well developed in guinea pigs (Werner, 14). This reflex is already present several hours after the birth (2), which is crucial for the determination of the hearing threshold in very young animals.

Experiment was carried out on 10 males and 70 young females of the reproductive age. After 4 weeks adaptation period and removal of the already pregnant females, 55 non-pregnant females were selected. In the adaptation period Males were placed in the "B" compartment. The females selected for the experiment were placed in the compartment "A", where they were exposed to the weaving shop noise throughout pregnancy in the following way: 8 hours daily for the 5 days during the week, 6 hours on Saturday with ~~the~~ rest on Sunday. This corresponds to a one-shift work week of the weaver. Males were kept in the compartment "B" during the exposure to the noise. Females were kept in the compartment "A" until the birth of the offspring and after that were removed to the compartment "C" with the acoustic pressure level of 34-36dB. The conditions in all compartments "A", "B", and "C" (temperature, sun light, ventilation) were good (21). All animals received sufficient amount of food which consisted of LSK feed, carrots, hay and milk.

ACOUSTICAL CONDITIONS IN THE EXPERIMENT

In the textile industry, the noise which is most damaging to the hearing is produced in the weaving shop (1,5,6,8,~~13~~12,17,19,24). Women comprise the majority of the workers in these shops and that prompted the choice of this particular kind of noise in the experiment. The apparatus emitting a weaving shop noise was placed in the "A" compartment. The detailed procedure for the recording and replaying noise were described elsewhere (9).

The total of 100 newborn guinea pigs, exposed to the noise throughout their fetal life, was investigated. The threshold hearing curves were obtained

with Polish audiometer Elza AUG-64-a, using chopper to obtain sudden, short lasting tone. The source of the sound was the earphone, which was placed 2 cm away from the guinea pigs ear. The tightening of the ears was used as the criterion for the reception of the acoustic stimulus. This symptom is called Preyer's pinna reflex. It is widely accepted that the hearing test using Preyer's reflex is the best way to conduct an audiometric study in animals (16,18). The audiometric study was conducted in the compartment "C" with the acoustic pressure level of 34-36db and thus the interference with the measurement was negligible [3,16]. The experiments were carried out between 12 noon and 2 PM every day by the same person using the same apparatus. The hearing tests were performed repeatedly : 1- on the third day of life; 2- on the seventh day of life; 3- on the fourteenth day of life; 4- on the thirteenth day of life. 5- on the sixteenth day of life. The tests on older animals were not performed, since there was a risk of other hearing damaging factors. Because of lack of the significant differences between audiometric results on 3, 7 and 14 days old animals, we will refer to the above three tests as Test I. Tests II and III will refer to the thresshold curves for 30-days and 60-days old animals respectively.

CONTROL GROUP

Control group consisted of 30 young guinea pigs, born to females isolated from the noise. They were kept in the comparment "C" under the same conditions as the experimental animals. The test conditions were identical.

RESULTS OF THE EXPERIMENTS

The results of the experiments on the control group are presented in Table I. Table II represents data on the experimental guinea pigs up to the 14th day of life. The results of the tests on 60 day old guinea pigs are presented in Table III.

The analysis of data presented in the tables I-III, shows that at the given frequency, more animals in the control group react to lower intensity signals. Moreover, among 60 day old guinea pigs, within the investigated frequency range,

more animals react to higher intensity tone, than among 14 day old. The number of animals failing to respond to the maximum available tone intensity (mainly at extremely low and high frequencies), is greater for the 60 day old.

* See Page 4a. ~~This data was compared with the results of the hearing tests on the adult guinea pigs (9). The comparison is presented in Table IV.~~

Statistical analysis of the ~~data on~~ decibel values in both groups of animals for all investigated frequencies was performed. The following quantities were computed; arithmetic mean, standard deviation, the value of most frequent measurement (dominant), standard error and the confidence limits. Next, the analysis of the significance of the mean differences was performed. The conclusion was that almost all the differences can be regarded as significant at the level of a = .01. The smallest differences are observed between Tests I and II (in animals up to 14 days old) (30 days old), the differences between Test II and III (60-day old) being ~~larger.~~ much more pronounced. The differences ~~still~~ further increase between Tests I and III. The ~~larger~~ greatest differences are between Test III and control group tests. On the basis of the obtained data ~~one concludes that the experimentally induced noise has a significant influence on~~ ** See Page 4a. the hearing impairment of the experimental animals (24). The results presented in the Tables III and IV, show correlation between the number of reacting animals at given tone intensities at the same frequencies, and between the number of animals failing to react, including the frequency distribution of the latter. The above results show that the audiometric picture of the hearing impairment in the guinea pigs which were exposed to the noise during their fetal life is identical to that of the hearing impairment in adult animals exposed to noise.

DISCUSSION OF THE RESULTS

The threshold curves for the newborn guinea pigs plotted on the basis of arithmetic mean values for a given frequency and on the basis of most probable values have the same trend as for the control group, being almost parallel. They are shifted down towards greater hearing loss, especially for the extremely low and

*Next the results for the primary group of young pigs were compared with results of our studies of hearing impairment induced in adult guinea pigs (9); the results for the adult group are in Table IV.

**it is possible to draw conclusions about the actual effect of test noise on

high frequencies. The cutoff of the threshold curve was observed in Test III, due to the loss at extreme frequencies.

No selective loss was observed around 4000H. It followed from the analysis of the threshold curves for Tests I, II and III that there is a progressive loss of hearing, even though the hearing traumatizing factor was removed at the moment of birth. The control group studies, however, did not reveal any significant differences. In the Test I and II, 50% and 35% of the animals respectively, did not show hearing impairment. In the Test III all the animals showed hearing impairment, although in 12% it was minimal. The deterioration of the hearing in the animals of the experimental group as was seen in the subsequent experiments was also caused by new factors. The biochemical damages produced by the increased acoustical pressure, might be contributing to that effect. It is found, that animals exposed to noise, develop hypoglucemia which is present long after the noisy environment is removed (13). One also can not exclude the effect of the vascular disorder which appears as a result of the application of the strong acoustic stimuli (15,23,27) and of the metabolic disorder (28). Also, it is not known whether the hearing traumatizing stimulus destroys the inner ear of the fetus, or causes changes in the other parts of the nervous system. Szmeja et al (26) did not observe any symptoms of the hearing impairment in the newborn guinea pigs, which were exposed to an industrial noise during their fetal life. Also, no change in the activity of dehydrogenase in the hearing cells and no degeneration of the Corti region and spiral coil were found. It is still an open question, since both the localization of the hearing damage and the mechanism for its occurence in the fetuses of guinea pigs are not known and require further study.

The acoustic stimulus, which in this experiment is the weaving shop noise. encounters various obstacles on its way to the fetus: skin, underskin tissue, muscles, uterus wall, embrionic fluid. All of the above obstacles reflect, absorb and refract part of the acoustic energy and only some of it gets to the guinea

pig fetus. The acoustic energy losses in men are known, (they were measured with the use of the microphone introduced into the uterus), and are of the order of few percent (20). One can guess that the loss is much smaller for guinea pigs because of the lesser acoustic barrier. In the case of weaving shop noise exceeding 100db for several hours a day exposure throughout the whole fetal life of the guinea pig, the stimulus is great enough to damage the young and developing hearing system of the animal.

CONCLUSIONS

1. The weaving shop noise, present throughout the fetal life of guinea pigs, causes hearing impairment.
2. The threshold curves, determined audiometrically in the early life of guinea pigs exposed to the noise in their fetal life, have the same trend as for the control group. The curves are lowered by about 10-15dB, with greater losses at extreme frequencies.
3. In 35% of the guinea pigs, the threshold curve had cutoffs caused by lack of the response at extreme frequencies.
4. In the first 60 days of life the progressive hearing impairment was observed in the animals born with the hearing impairment. Also, the appearance of the audiometric symptoms of the hearing loss was observed in animals born with normal hearing.

   50% of the animals did not have any hearing damage up to the 14th day of life.

   On the 60th day of life all of the experimental guinea pigs showed a hearing impairment.

TABLE I

CONTROL GROUP

TONE INT.	FREQUENCY [Hz]							
dB	1000	1500	2000	3000	4000	6000	8000	10000
60								36
65						1	7	14
70					2	7	23	
75					7	20		
80			3	7	38	2		
85			35	19	3			
90		32	12	4				
95	32	38						
100	36							
105								
110								

TABLE II

EXPERIMENTAL GROUP (UP TO 14TH DAY OF LIFE)

TONE-INT.	FREQUENCY [Hz]							
dB	1000	1500	2000	3000	4000	6000	8000	10000
60								1
65								12
70						4	24	40
75					2	26	52	35
80					38	51	22	12
85				9	24	52	7	2
90			2	70	64	7	2	
95	2		23	26	20	—		
100	76		51	8	3	1		
105	23		19					
110	1		2					

TABLE III

EXPERIMENTAL GROUP (60TH DAY OF LIFE)

TONE INT.	FREQUENCY [Hz]							
dB	1000	1500	2000	3000	4000	6000	8000	10000
60								
65								1
70							1	—
75						6	21	38
80					3	27	37	40
85				1	29	40	27	
90			21	37	40	19	7	
95		4	37	39	23	2		
100	30	31	30	19	4	2		
105	47	38	7	2				
110	9	23	3	1				
NO REACT.	14	4	2	1	1	1	7	21

TABLE IV

ADULT GUINEA PIGS WITH THE
EXPERIMENTALLY INDUCED
HEARING IMPAIRMENT

TONE INT.	FREQUENCY [Hz]							
dB	1000	1500	2000	3000	4000	6000	8000	10000
60								
65								2
70						3	5	7
75						7	13	16
80				2	1	8	18	13
85				6	7	12	6	4
90			5	16	15	13	4	—
95			14	9	10	9	2	1
100	16	14	9	5	7	—		
105	15	9	4	2	2			
110	4	0	3	3	3	5	9	20
NO REACT.	10	8						

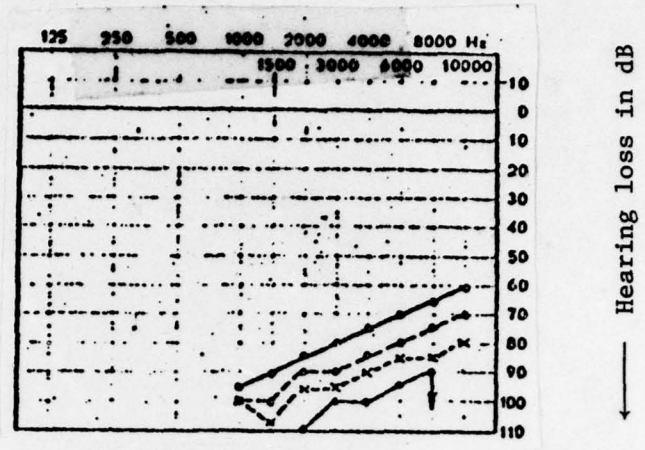

Fig. 1. Threshold curves of the guinea pig No. 5 from the control group and of the guinea pig No. 66 from the experimental group.

—o———o— guinea pig No. 5 (same results for the 14th, 30th and 60th day of life)

-o---o- guinea pig No. 66: 14th day of life

-x---x- guinea pig No. 66: 30th day of life

-o---o- guinea pig No. 66: 60th day of life

EFFECTS OF WEAVING SHOP NOISE ON THE AUDITORY ORGAN OF GUINEA PIG FETUSES

Summary

Using Preyer's pinna reflex the author plotted audiometric curves in 100 young guinea pigs exposed throughout their fetal life to noise in a weaving shop. Hearing acuity determinations were carried out on days 3, 7, 14, 30 and 60 of life. In successive determinations progression of hearing impairment was observed even despite the fact that the acoustic traumatizing factor ceased at the time of birth. Up to the 14th day of life hearing impairment was found in 50% of guinea pigs and on the 60th day of life signs of hearing impairment due to acoustic trauma were observed in all cases.

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